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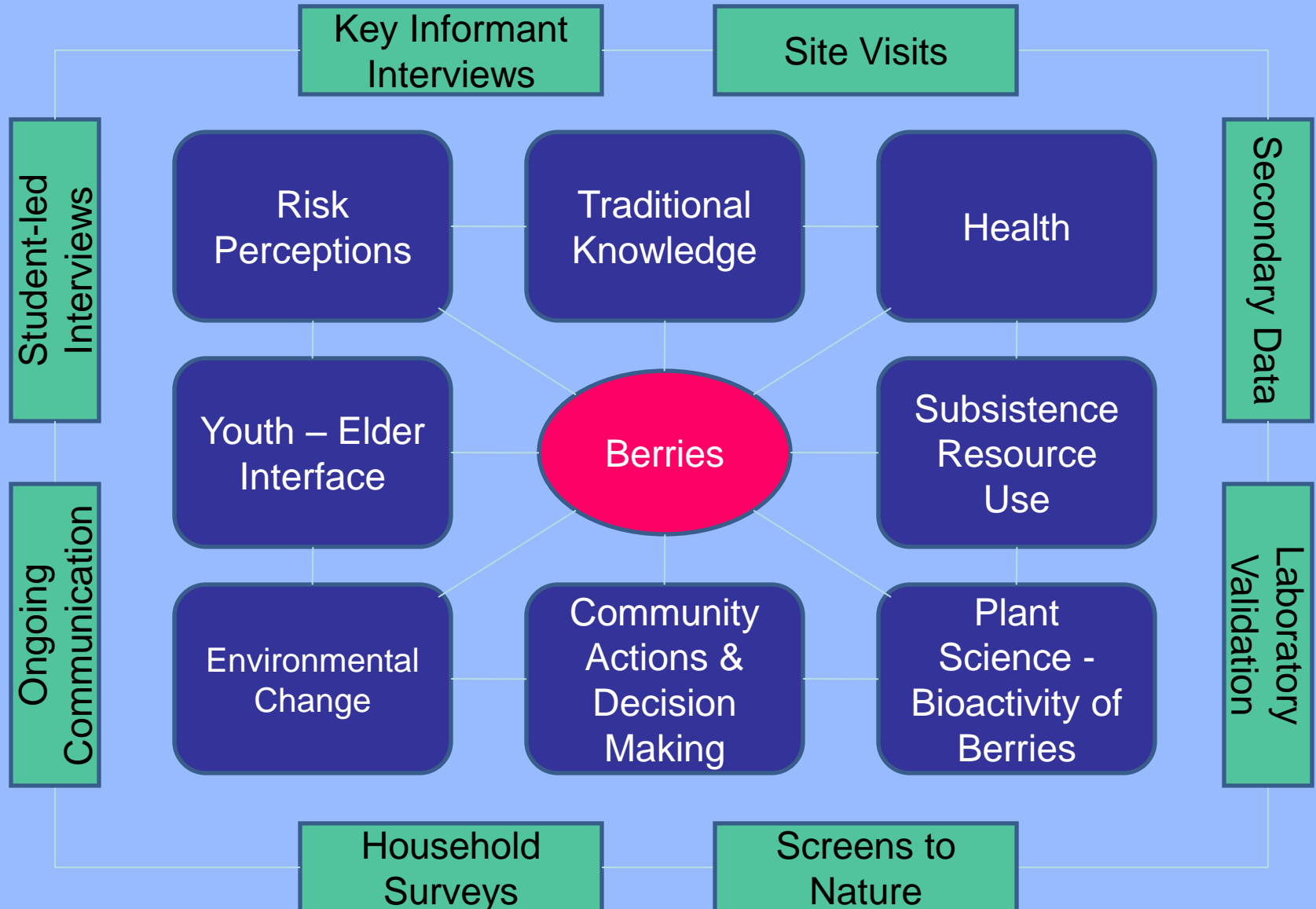


► USEPA-STAR

“Impacts of Climate Change on Health
Benefits of a Tribal Alaskan Resource:
Integrating Traditional Ecological
Knowledge With Risk Assessment
Through Local Monitoring”



Community Participatory Research Framework



Alaska Tribal Berry Resources & Human Health Under the Cloud of Climate Change

The Project Framework:

- Transdisciplinary Methods Development
 - Biological Sciences
 - Social Sciences
 - Community Participation
- Integrated Inquiry
 - Stress, Berries & Health Benefits
 - The Question of Climate Change
 - Community/Environmental Health & Risk
 - Traditional Ecological Knowledge
 - Implications for Community Wellness



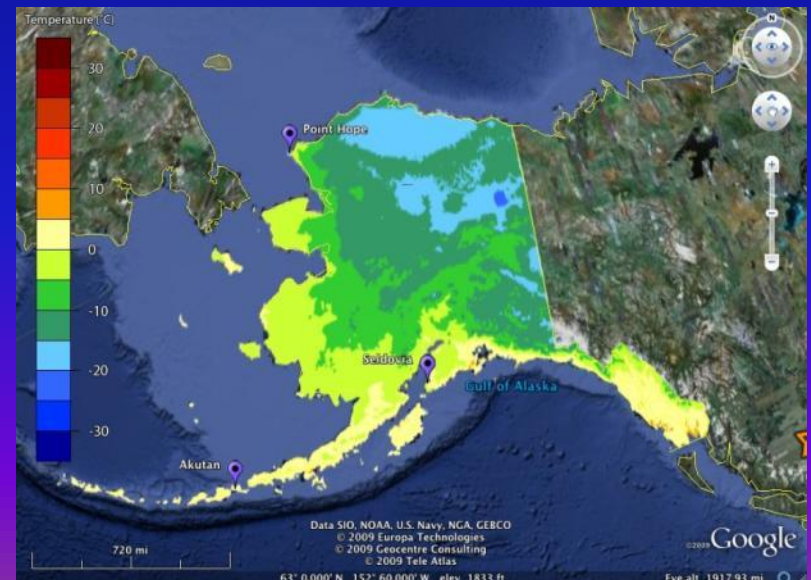
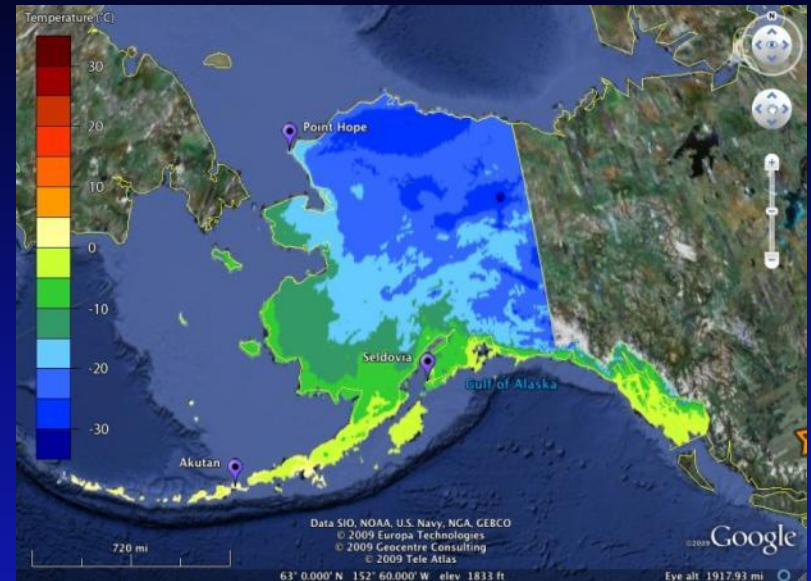
Climate Impacts?

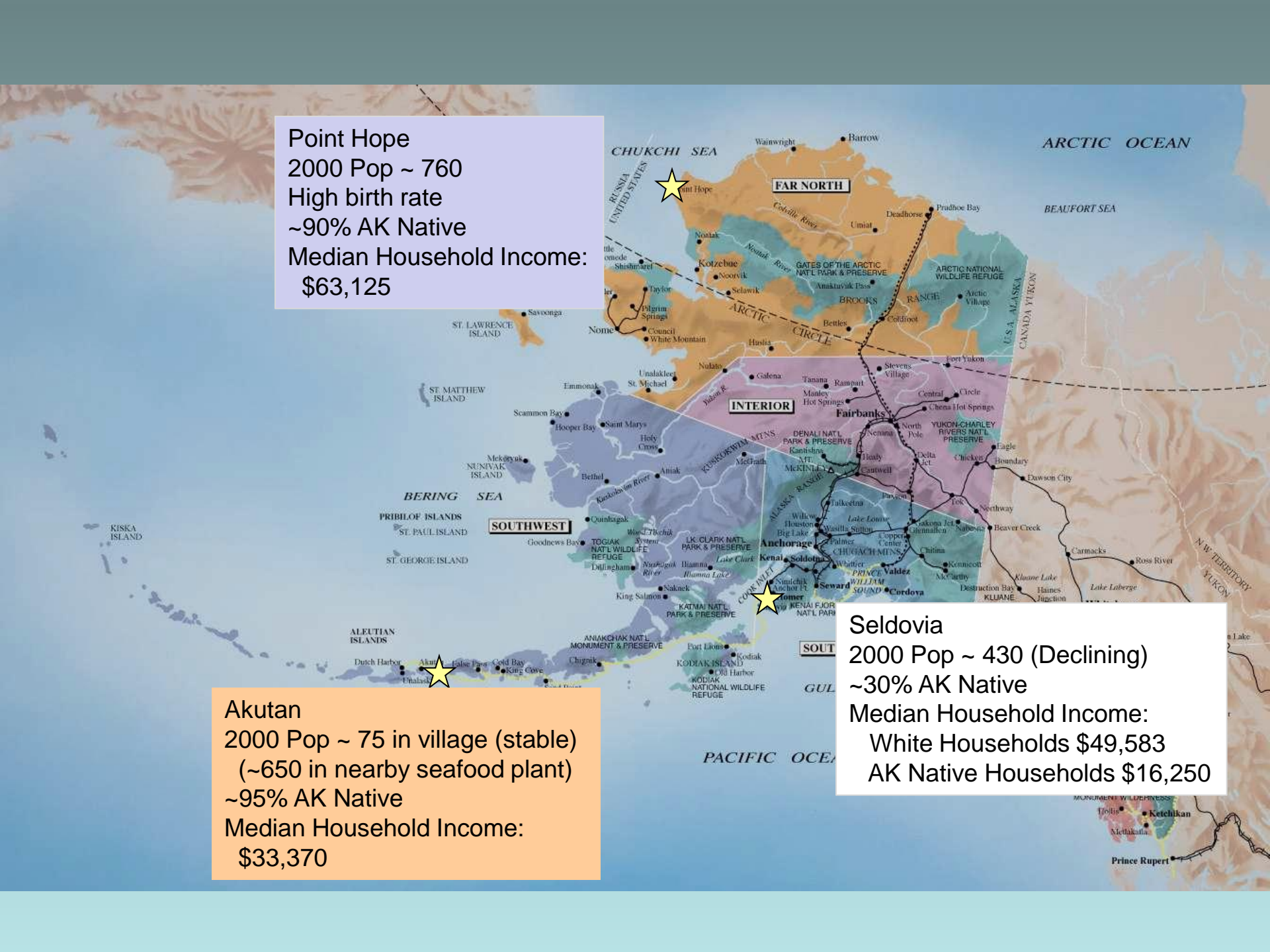
Pros

- Longer growing period
- More vegetative growth present
- Warmer temperatures

Cons

- Increased in competition from other plants
- Warmer winters could decrease stresses





Point Hope
2000 Pop ~ 760
High birth rate
~90% AK Native
Median Household Income:
\$63,125

Akutan
2000 Pop ~ 75 in village (stable)
(~650 in nearby seafood plant)
~95% AK Native
Median Household Income:
\$33,370

Seldovia
2000 Pop ~ 430 (Declining)
~30% AK Native
Median Household Income:
White Households \$49,583
AK Native Households \$16,250

Vaccinium uliginosum

[bog blueberry]

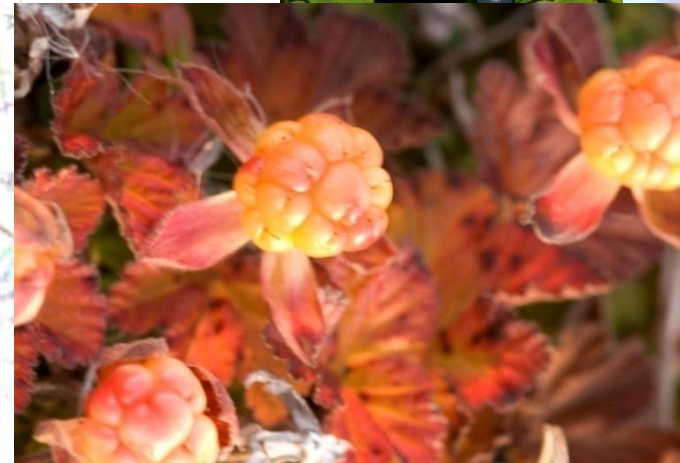
Vaccinium ovalifolium

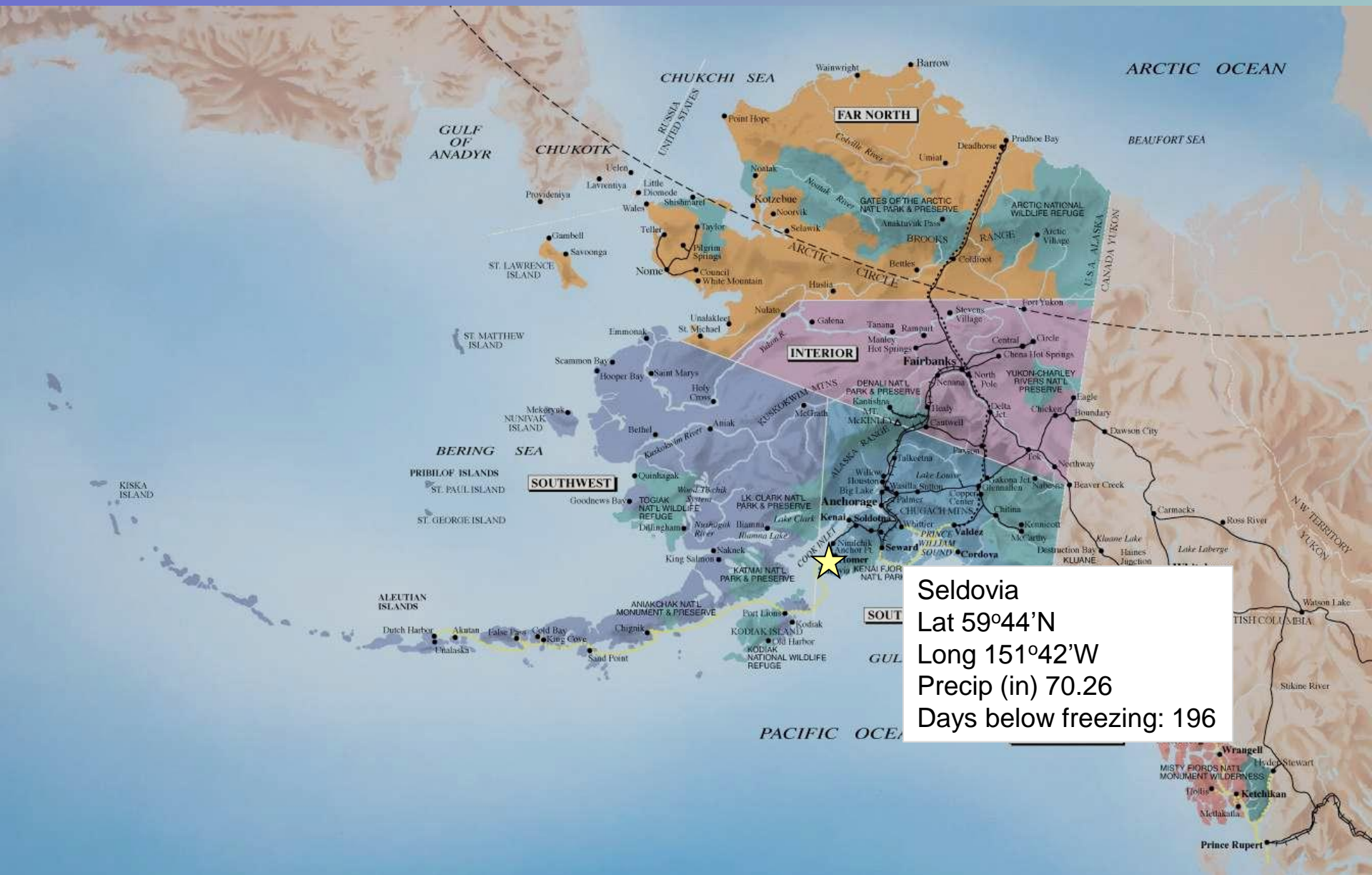
[blue huckleberry]

Rubus chamemorous [cloudberry
aka salmonberry]

Rubus spectabilis
[salmonberry]

Empetrum nigrum
[crowberry
aka mossberry
aka black berry]

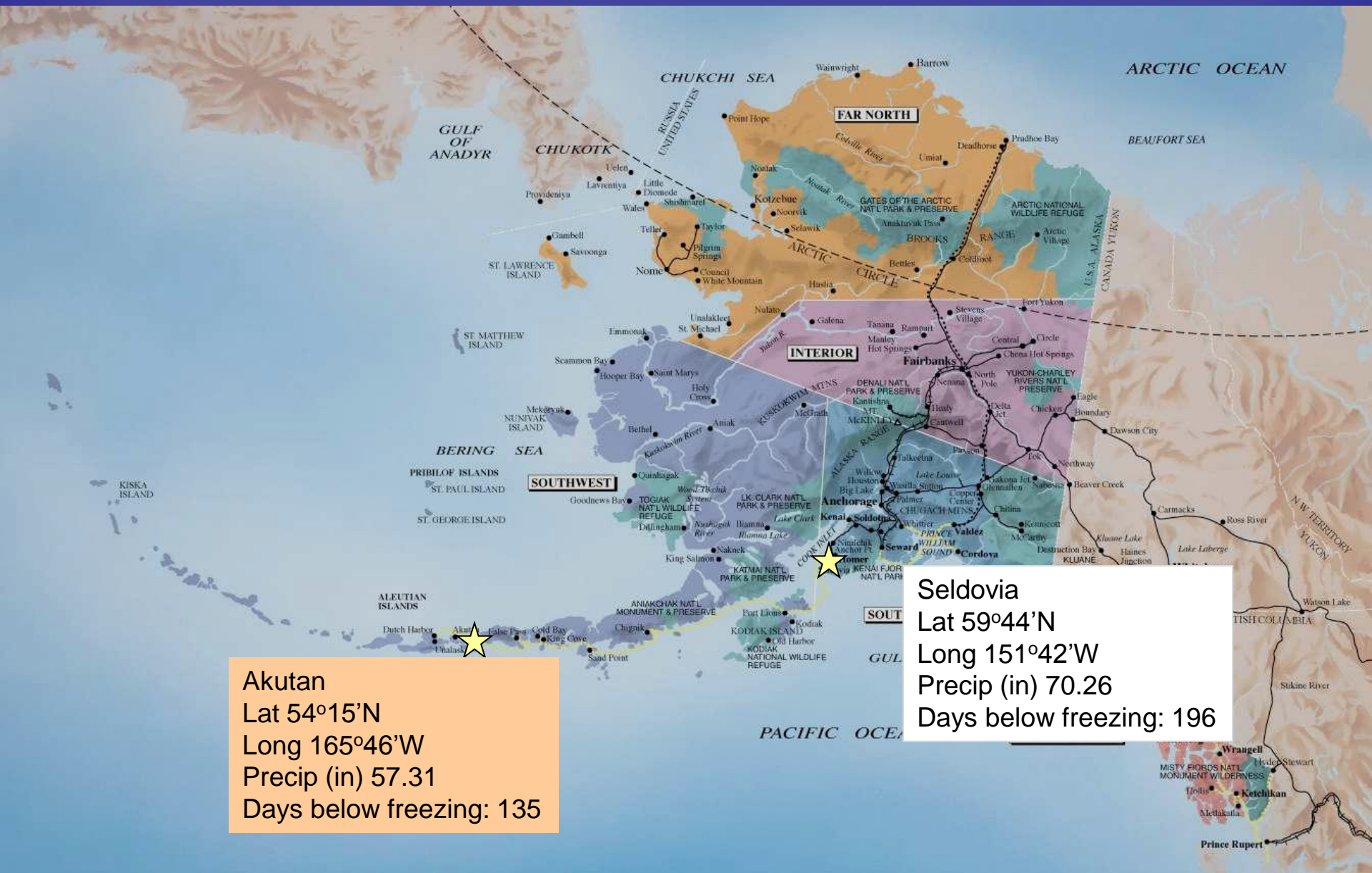






Seldovia





Akutan
Lat 54°15'N
Long 165°46'W
Precip (in) 57.31
Days below freezing: 135



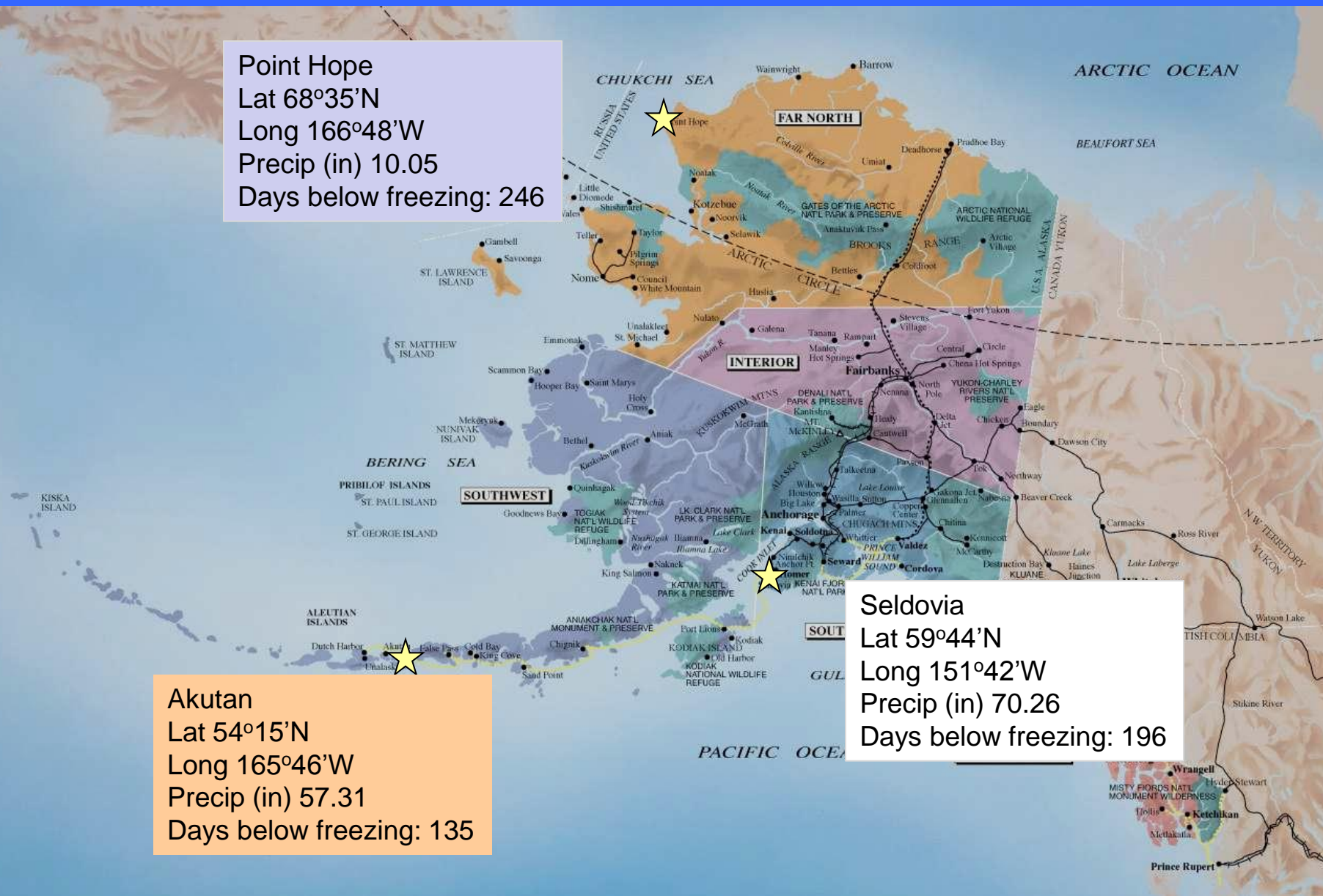
Josh Kellogg



Akutan (the Aleutian Islands)



Point Hope
Lat 68°35'N
Long 166°48'W
Precip (in) 10.05
Days below freezing: 246



Seldovia
Lat 59°44'N
Long 151°42'W
Precip (in) 70.26
Days below freezing: 196

Akutan
Lat 54°15'N
Long 165°46'W
Precip (in) 57.31
Days below freezing: 135









Josh Kellogg

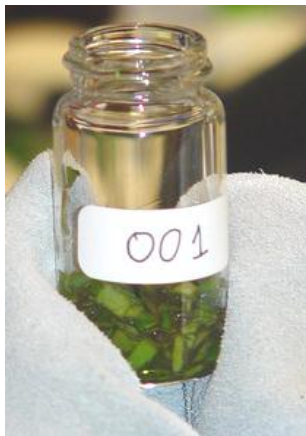


STN Training Sessions

In field
&
In school

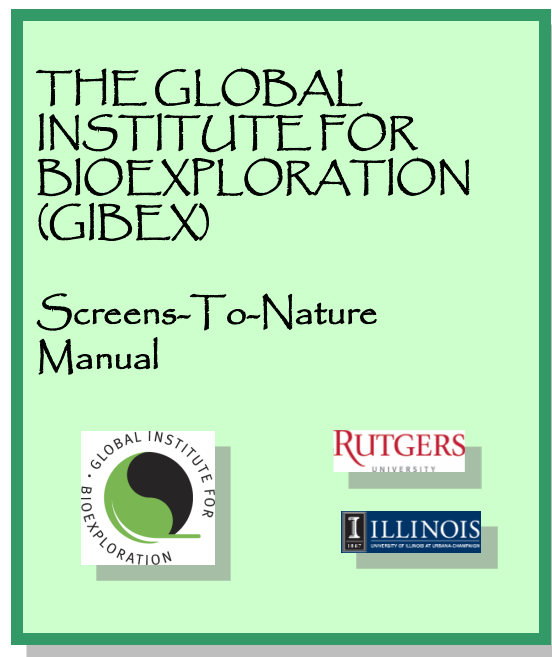


STN Manual – An Effective Tool for Technology Transfer



Currently Available STN Technologies

- **Amylases and amylase inhibitors**
- **Proteases and protease inhibitors**
- **Antioxidants**
- Glucosidase and glucosidase inhibitors
- Anti-microbial (2 screens)
- Anti-fungal (2 screens)
- Anti-nematodal
- Anti-flat worms
- Tyrosinase inhibitors
- UV blockers
- Total alkaloids
- Total anthocyanins / polyphenols
- Brine shrimp lethality assay
- Planaria regeneration assay



Antioxidant Screen

Targets: Chronic diseases:

Cancer, Diabetes, Heart disease, Alzheimer's disease, and Parkinson's disease

MATERIALS

1 x 96 well plate

3.5 mg ABTS

(2,2 Azino-bis (3-ethylbenzo-thiazoline-6-sulfonic acid) diammonium salt) - ABTS

0.5 mg Potassium persulfate (K₂S₂O₈)

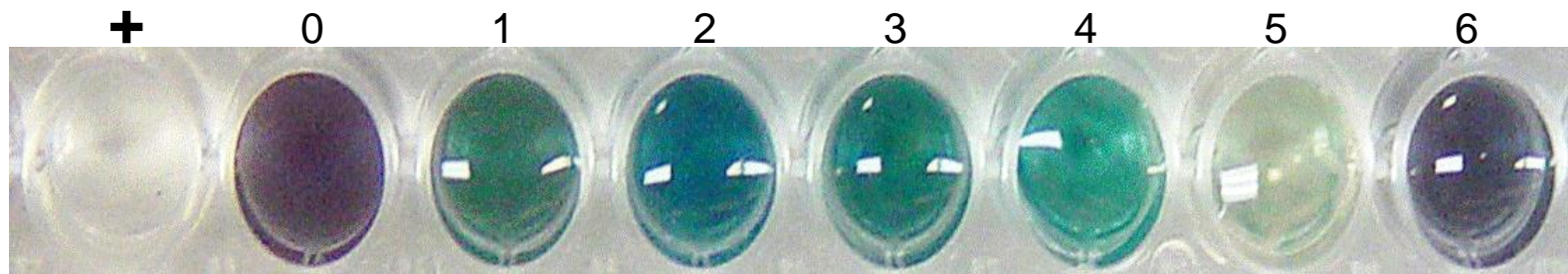
1mM ascorbic acid solution (17.6 mg/ml) or known antioxidant

Permanent marker

Plant extracts to be tested

10µl and 100µl pipettes with corresponding tips

24 ml water



Sample 5 would be recorded as “3”; Samples 1- 4 would be recorded as “1”; Sample 6 would be recorded as “0”

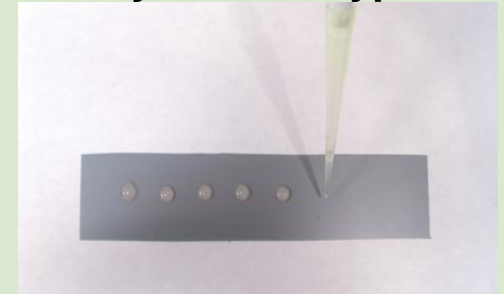
Dual Assay for Protease Inhibitors and Proteases Using X-Ray Film

Targets: HIV / AIDS, parasitic diseases, metabolic disorders

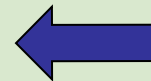
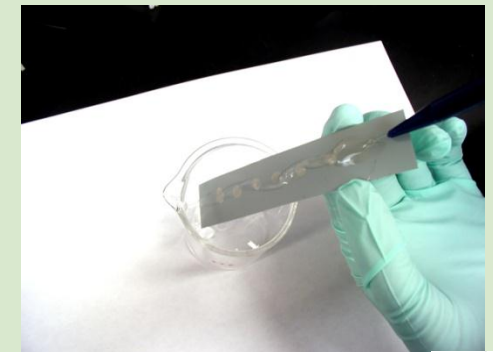
Make an extract



Place on surface of x-ray film +/- trypsin



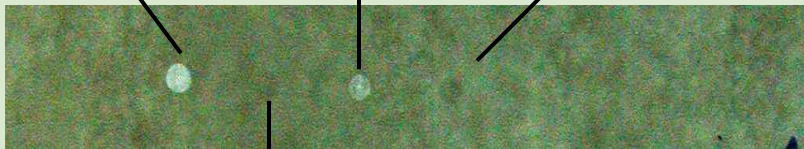
**Incubate for 15 min,
wash with water**



**Trypsin -
positive
control**

**Protease
(source:
pineapple
juice)**

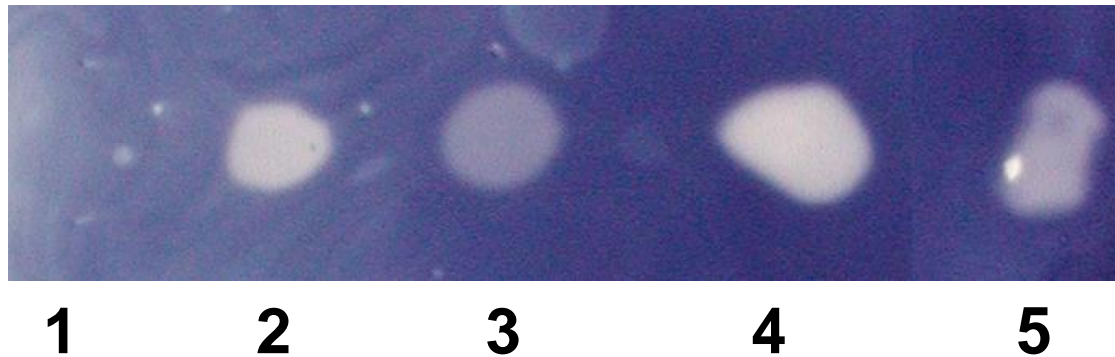
**Negative
control
(gelatin preserved)**



**Protease inhibitor
(source: potato juice
with trypsin)**

Glucosidase and Amylase Inhibitory Activity

Targets: Metabolic syndrome



- (1) Water
- (2) Amylo-glucosidase (positive control)
- (3) Amylo-glucosidase and acarbose (positive control for inhibition)
- (4) Amylo-glucosidase and pea extract (known to have strong alpha-glucosidase activity and no inhibitors)
- (5) Amylo-glucosidase and white bean extract (known to have inhibitors for alpha-glucosidase activity)

A composite image. The main part shows a young boy with blonde hair, wearing a blue and black camouflage long-sleeved shirt, standing and pouring a white liquid from a white plastic cup into a clear test tube. He is looking down at the test tube. To his left, a woman with brown hair and glasses, wearing a blue zip-up jacket, is seated and watching him. To his right, a woman with dark hair, wearing a black jacket, is also seated and looking at him. In the background, there are computer monitors and office equipment. In the bottom right corner, there is an inset image showing a camouflage-patterned baseball cap.



Technical Assessments of Alaska Community/Environment Risks

- Arctic Climate Change
- Environmental Contamination/Threats
- Natural Resource Stress
- Alaska Native Health Risks
- Behavioral Health Risks
- Loss of Traditional Knowledge & Practices

Figure 1: Number of Alaska Native People Living in Alaska with Diabetes by Year

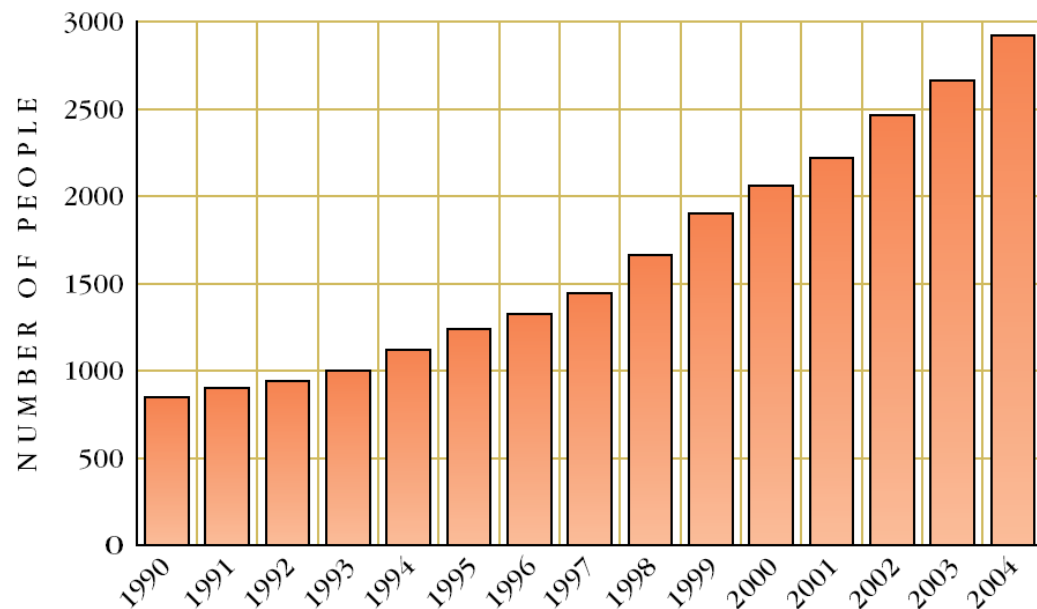
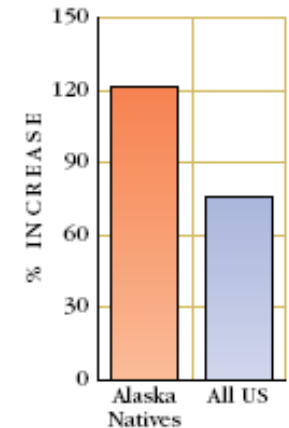
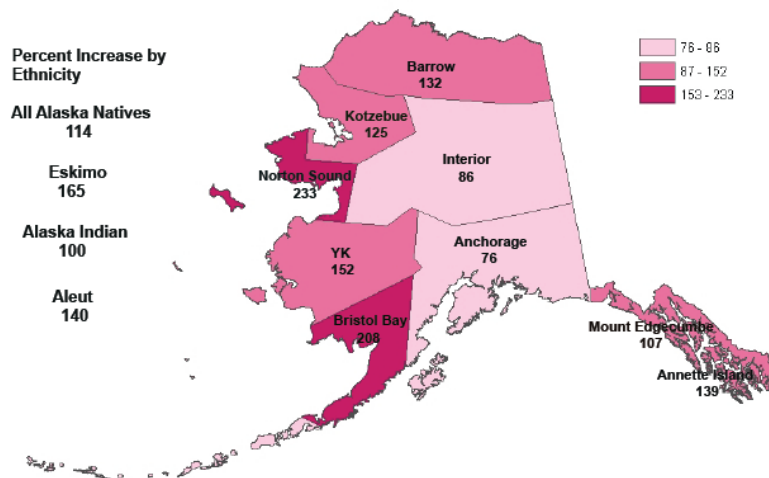


Figure 3: Percent Increase in Diabetes Prevalence among Alaska Natives and in US: 1990-2004



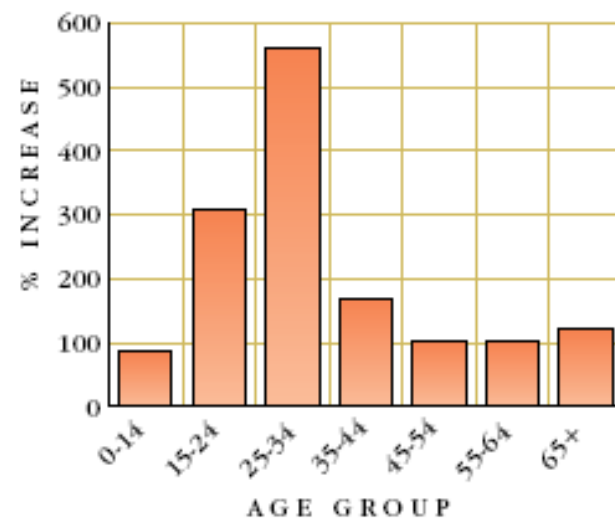
Based on prevalences age adjusted to US standard 2000

1990-2006 PERCENT INCREASE IN DIABETES PREVALENCE
Using User Population as Denominator
Regions By Previous Indian Health Service Units
Age-adjusted to the Standard U.S. 2000 Population



Source: Alaska Native Medical Center Diabetes Registry

Figure 4: Percent Increase in Prevalence of Diabetes by Age, Alaska Natives from 1990 to 2004



Based on prevalences age adjusted to US standard 2000 population

Local Risk Perceptions

	Akutan	Point Hope	Seldovia
Climate Change	Observed (cooling) Low RP	Observed High RP	Divergent Views, Low RP
Environmental Contamination	Moderate	High	Low
Threats to Subsistence Resources	Low	High	Moderate
Health Concerns	Moderate	High	Moderate
Behavioral Risks	Low	High	Moderate
Loss of Traditional Knowledge & Practices	Low	Low	Low

Interviews & Surveys

Interviews:

Akutan (11) - Point Hope (24) - Seldovia (30)

Survey Response Rates :

Akutan	19/36	52.7% response
Point Hope	36/190	5.2% response
Seldovia	61/169	36.1% Response

Alaska Community Berry Survey Akutan



Part of a three-year study funded by the US Environmental Protection Agency
and conducted with the approval of the Akutan Traditional Council

Dr. Courtney Flint

Department of Natural Resources and Environmental Sciences
College of Agriculture, Consumer, and Environmental Sciences
University of Illinois at Urbana-Champaign



Alaska Community Berry Survey Point Hope



Part of a three-year study funded by the US Environmental Protection Agency
and conducted with the approval of the Native Village of Point Hope and help
from students from Tikigaq School

Dr. Courtney Flint

Department of Natural Resources and Environmental Sciences
College of Agriculture, Consumer, and Environmental Sciences
University of Illinois at Urbana-Champaign



Alaska Community Berry Survey Seldovia



Part of a three-year study funded by the US Environmental Protection Agency
and conducted with the approval of the Seldovia Village Tribe

Dr. Courtney Flint

Department of Natural Resources and Environmental Sciences
College of Agriculture, Consumer, and Environmental Sciences
University of Illinois at Urbana-Champaign



Favorite Berries



Akutan

#1 = Blueberries

#2 = Salmonberries

Point Hope

#1 = Salmonberries

#2 = Blueberries

Seldovia

#1 = Blueberries

#2 = Salmonberries



Why Do You Pick Berries?

Akutan: #1 for personal or family food
 #2 to be outside
 #3 for fun
 #4 for traditional reasons

How Do You Eat Berries?

- With milk and/or sugar
- Jams and jellies
- Plain/raw, “just the way they are”
- With cereal, cool whip, or ice cream
- Agutuk (Eskimo ice cream w/caribou fat or seal oil)
- In desserts, pudding, muffins, cakes, and pies
- In sauce with oil

#5 to be with family and friends
#4 for traditional reasons



Health Benefits

Do you agree or disagree with these statements about possible health benefits of berries?

Agree-
Strongly
Agree

Berries contain a lot of vitamins

A - PH - S

Berries can help with a balanced diet

P H - S

Berries can help prevent diabetes

PH

Berries can help prevent cancer

Berries are good for your digestive system

P H - S

Berries can help lower blood sugar levels

Berries can protect you from infection

Local Perspectives on Health



Akutan/Seldovia

Moderate concerns about health (diabetes, cancer, alcoholism) linked to behavior and diet, not environmental risks

Point Hope

Strong concerns about cancer, diabetes, obesity, and dental health

Tied to environmental risks (lead, radioactivity, mining) & behavioral changes (junk food diet, lack of activity)

Some concern about drugs and alcohol



In all three communities, tribal health issues were linked to loss of traditional way of life and decreased emphasis on subsistence resources and foods

Perceived Threats to Berries

Seldovia: #1 Climate Change
other - access, logging, seasonal variations

Akutan: #1 Loss of Traditional Knowledge
#2 Climate Change
#3 Soil Contamination
other - effects of seasonal fluctuations

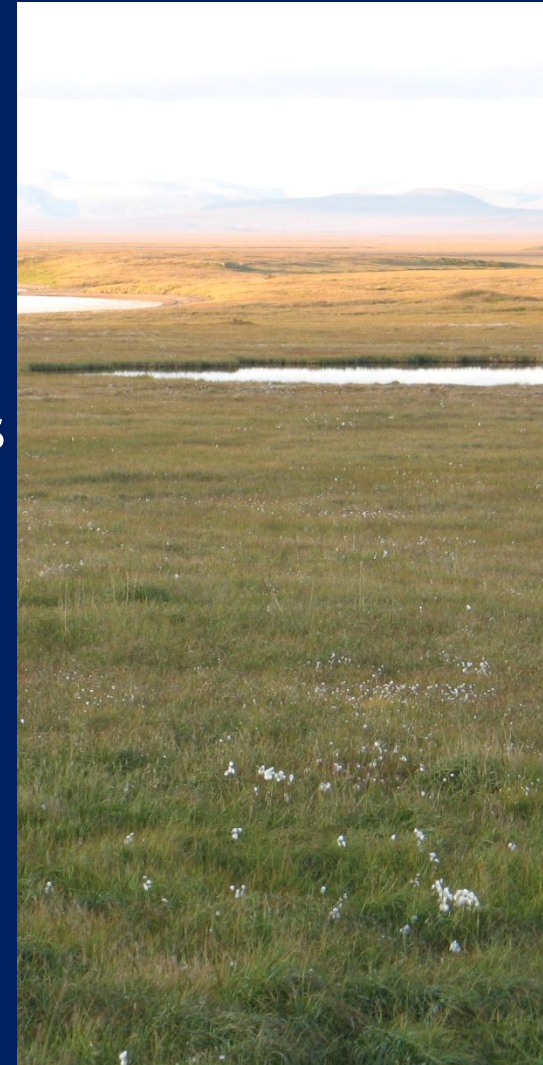
Point Hope: #1 Climate Change
#2 Radioactive Contamination
#3 Mining
#4 Waste Disposal & Incineration
#5 Loss of Traditional Knowledge
other - oil/gas spills



Note: Threats with scores above 3 (on 1-5 scale)

Climate-Berry Observations

- Need right amount of sunshine and water
- Need enough rain (but not too much)
- If too cold, berries don't grow/ripen
- Warm summer is good for berries
- Hot/dry summer is not good, dries out berries
- Winter snow is important for moisture
- Early freeze, berries don't ripen



Observations on Climate Change



Point Hope

Climate change observed & seen as major risk

Akutan

Mixed observations (cooling, warming)
Uncertainty about impacts

Seldovia

Mixed reactions, little articulation of risk
Observations of summer cooling trend
Climate change viewed as cyclical, not a continuous warming trend and not “global warming”

Local Perspectives on Berries

Berries are very important to each community

Sharing berries is an important tradition

Berry picking is valued for outdoor fun and for health reasons as well as for food

Women have traditionally picked berries, but a few men do pick berries in each community

Access to berries is a concern in Seldovia where there is a commercial operation for berry processing

Selling berries is not part of Point Hope or Akutan experience

Seasonal fluctuations affect berry quality & abundance (moisture/sun, winter weather, frost timing)



Observations on Quality of Life

Point Hope	Top Factors	Honoring traditions & cultural heritage Community supporting each other
	Serious problems	Lack of youth activities, Coastal erosion
Akutan	Top factors	Clean & safe environment Availability of basic needs
	Serious problems	Housing, Loss of traditional knowledge
Seldovia	Top factors	Clean & safe environment, Community supporting each other
	Serious problems	Employment Opportunities, Outmigration





Traditional Ecological Knowledge at Risk?

“It is important to differentiate between situations where a community’s TEK is adapting to new environmental and economic conditions and where TEK is being lost due to a disruption of transmission or population loss. Just because land use activities have changed or decreased does not necessarily mean that a community’s TEK is deteriorating.” (Menzies and Butler 2006, p.8)

Alaska STN Results

Berry	Ripe/ Unripe	Protease Assay	Protease Inhibitor Assay	Amylase Assay	Amylase Inhibitor Assay	Antioxidant Assay
from Akutan, Alaska						
<i>Rubus spectabilis</i>	R	No	Yes	0	1	2
<i>Rubus spectabilis</i>	U	No	No	0	1	1
<i>Vaccinium ovalifolium</i>	R	No	Yes	0	2	3
<i>Vaccinium ovalifolium</i>	U	No	No	0	1	1
<i>Empetrum nigrum</i>	R	No	Yes	0	2	2
<i>Empetrum nigrum</i>	U	No	No	0	1	2

Results based on 0-3 scale, with 3 having highest activity

- Berries from other sites demonstrated similar results in STN assays.
- Results suggest that the bioactive chemistry develops as the fruit ripens.
- All berries have antioxidant potential
- *V. ovalifolium* and *E. nigrum* have heightened potential for amylase inhibition compared to *R. spectabilis*
- Protease inhibition is found in all species





Frozen Berry fruits

1. Extract with MeOH (0.3% TFA)
2. Evaporate MeOH.
3. Load aqueous layer on Amberlite

Amberlite
XDA-7 column



1. Water (TFA)

2. MeOH (0.3% TFA)

Water wash
(Sugars)

Phenolic Rich
Extract (PRE)

Sephadex LH-20
Column

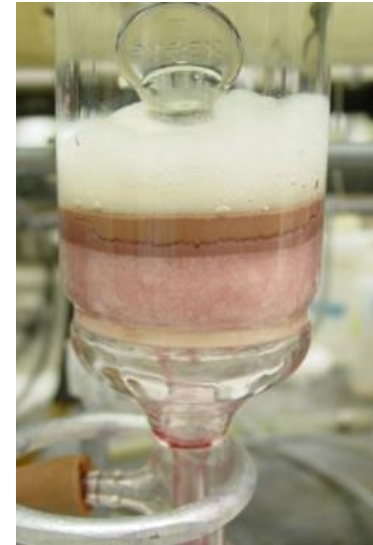


1. 20% aq-MeOH (0.3% TFA)

2. 70% aq-Acetone

Anthocyanin-Rich
Extract (ARE)

Proanthocyanidin-
rich extract (PAC)



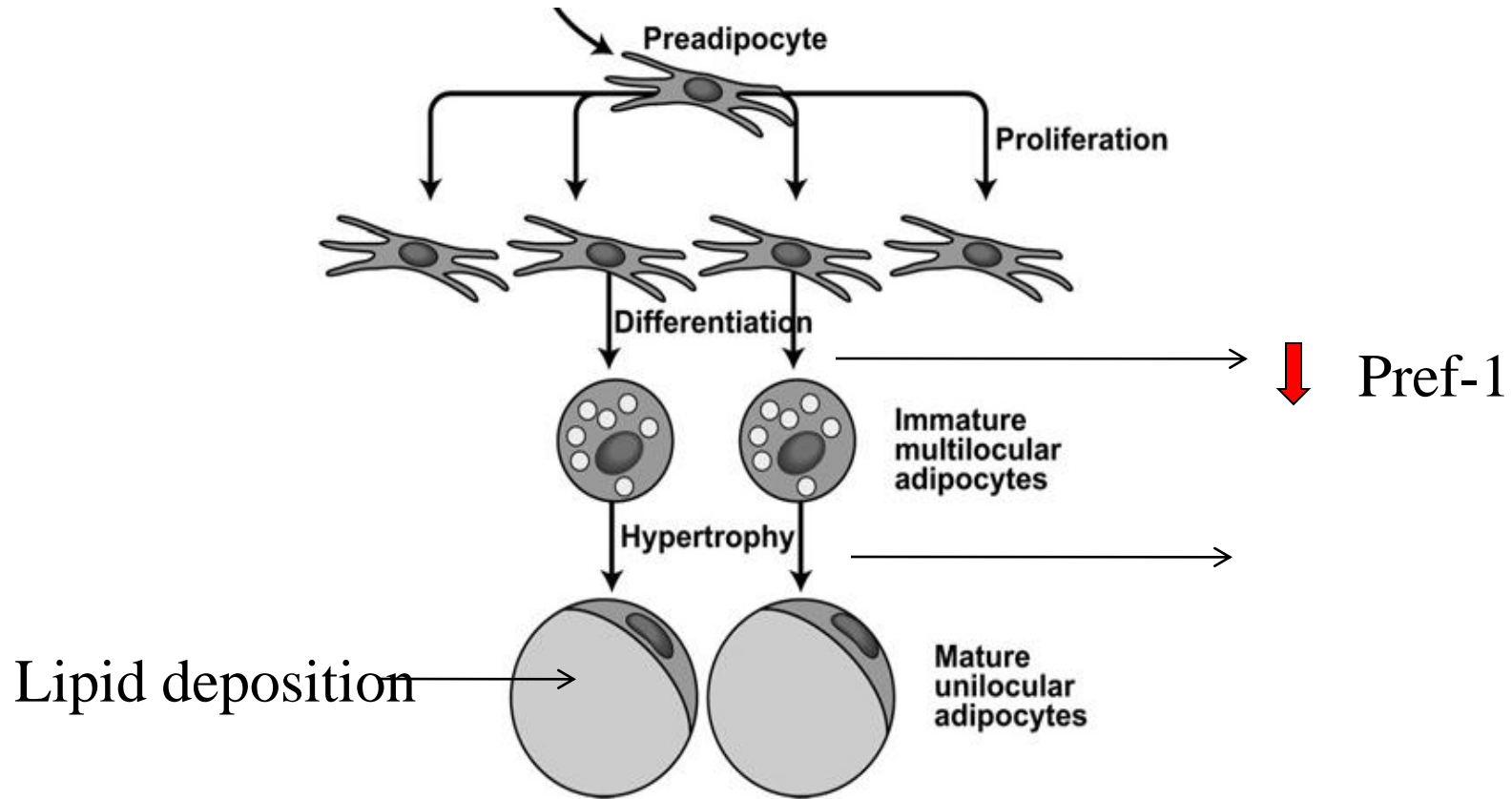
A-types in wild Alaskan berries

	m/z	AK-VO	SD-VO	AK-EN	PH-EN	SD-EN	AK-VU	PH-VU	AK-RS	SD-RS	PH-RC
Dimer											
(e)C-A-(e)C	577,425,287		✓	✓	✓	✓	✓	✓	✓		
(e)C-A-(e)Gc	593,303,287	✓	✓	✓	✓	✓	✓				✓
(e)Gc-A-(e)Gc	609,303,287	✓	✓				✓				✓
Trimer											
(e)C-A-(e)C-A-(e)C	863,573								✓	✓	
(e)C-(e)C-A-(e)C	865,577			✓	✓	✓	✓	✓	✓	✓	
(e)C-A-(e)C-(e)C	865, 575	✓	✓								
(e)Gc-(e)C-A-(e)C	881,729,577		✓	✓	✓	✓		✓			
(e)Gc-(e)Gc-A-(e)C	897,593,441			✓	✓	✓					
(e)Gc-(e)Gc-A-(e)Gc	913,609			✓							
Tetramer											
(e)C-(e)C-A-(e)C-A-(e)C	1151,863,573	✓									
(e)C-(e)C-A-(e)C-(e)C	1153,865,575		✓						✓		
(e)C-(e)Gc-(e)C-A-(e)C	1169,881, 729,577				✓			✓			
(e)C-(e)C-A-(e)Gc-A-(e)Gc	1183,1021, 895,605									✓	

- All berries studied contained at least a single A-type PAC.
- Some structures were found to be species-specific (see green highlights)
- Most of these are novel results, having never been described in these berries before.

Follow up phytochemical analysis with 3 bioassays

Adipogenesis and Lipid Metabolism



Fatty acid synthase (FAS) lipid synthesis
Lipoprotein lipase (LPL) lipid uptake ↑

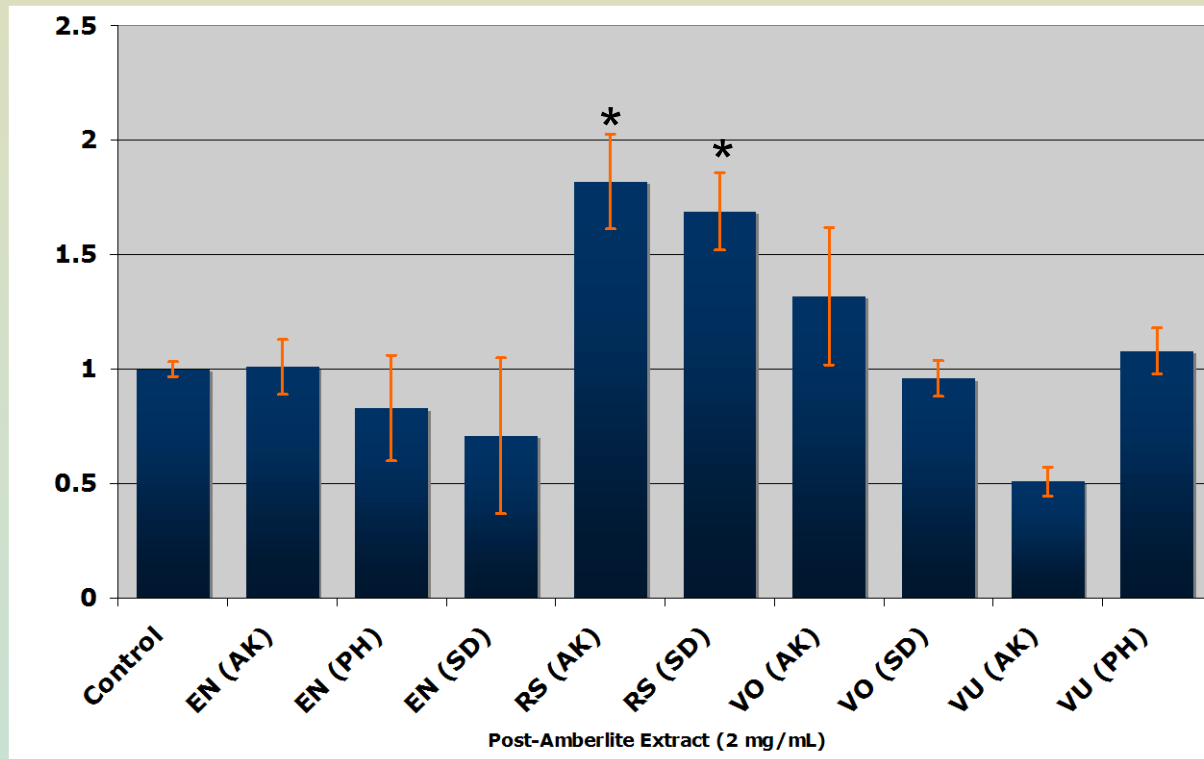
PREF 1 BioAssay

(aka: how to keep fat cells immature, not 'fat')

- Pref-1 is protein which inhibits the maturation process of mature adipocytes, keeping them in an immature form.
- Increasing or maintaining levels of Pref-1 could potentially offset the amount of mature adipose tissue present, which is the form that accumulates triglycerides.



AK berries influence on Pref-1 expression levels



* - $p \leq 0.05$

- *R. spectabilis* significantly increased Pref-1 levels in immature 3T3-L1 adipocytes.
- These berries are the lowest in levels of AC and PAC, suggesting something else at work.

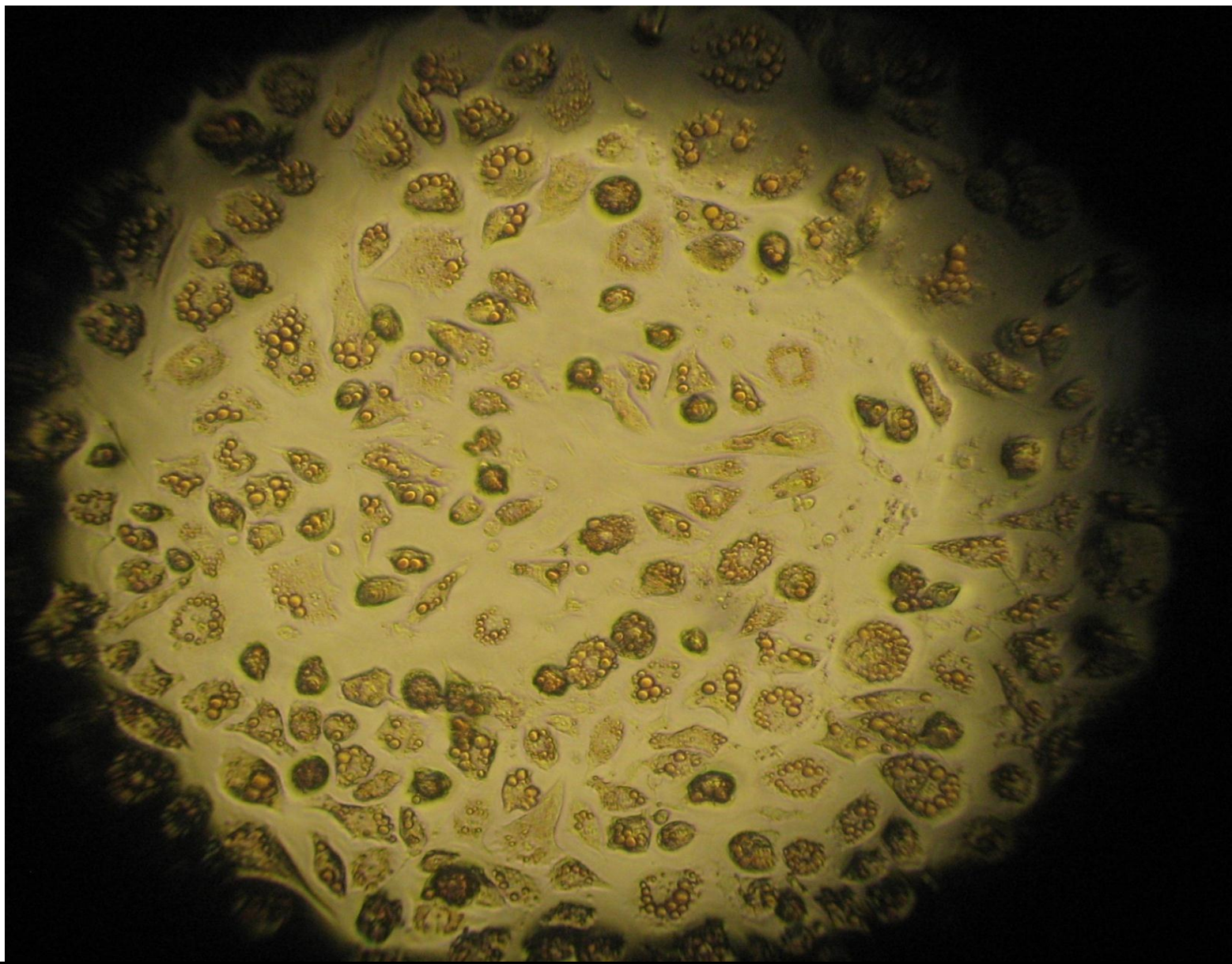


FIGURE 1. VISUALIZATION OF FAT DROPLETS IN 3T3 L1 MATURE ADIPOCYTES.

Oil Red O Assay

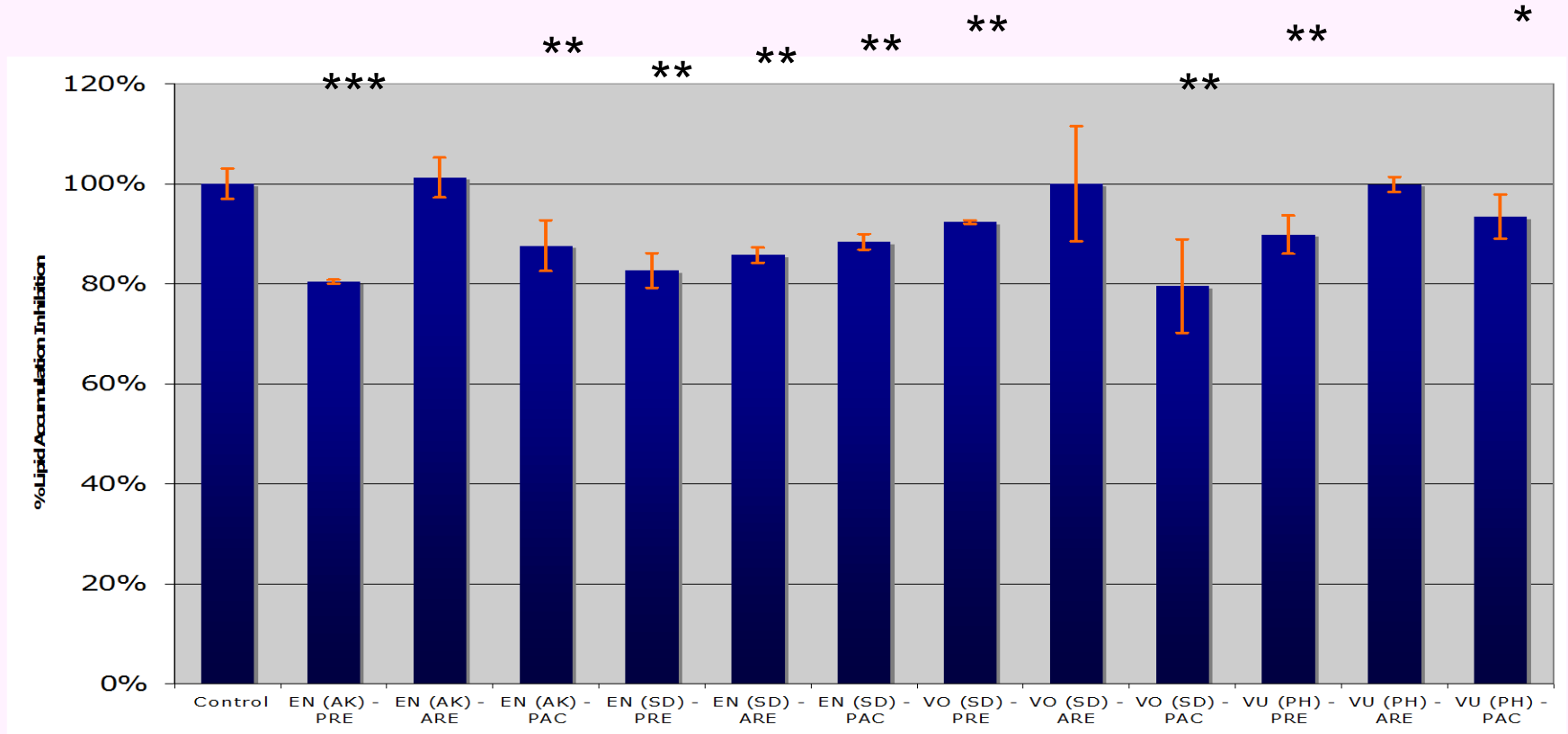
(aka: lipid (fat) accumulation assay)

The assay measures the amount of triglycerides (TG) accumulated by mature 3T3-L1 adipocyte cells (fat cells).

Alaskan berries, which have high levels of anthocyanins, proanthocyanidins, and other flavonoids, *should* o substantially decrease TG levels in 3T3-L1 adipocytes (mature fat cells).

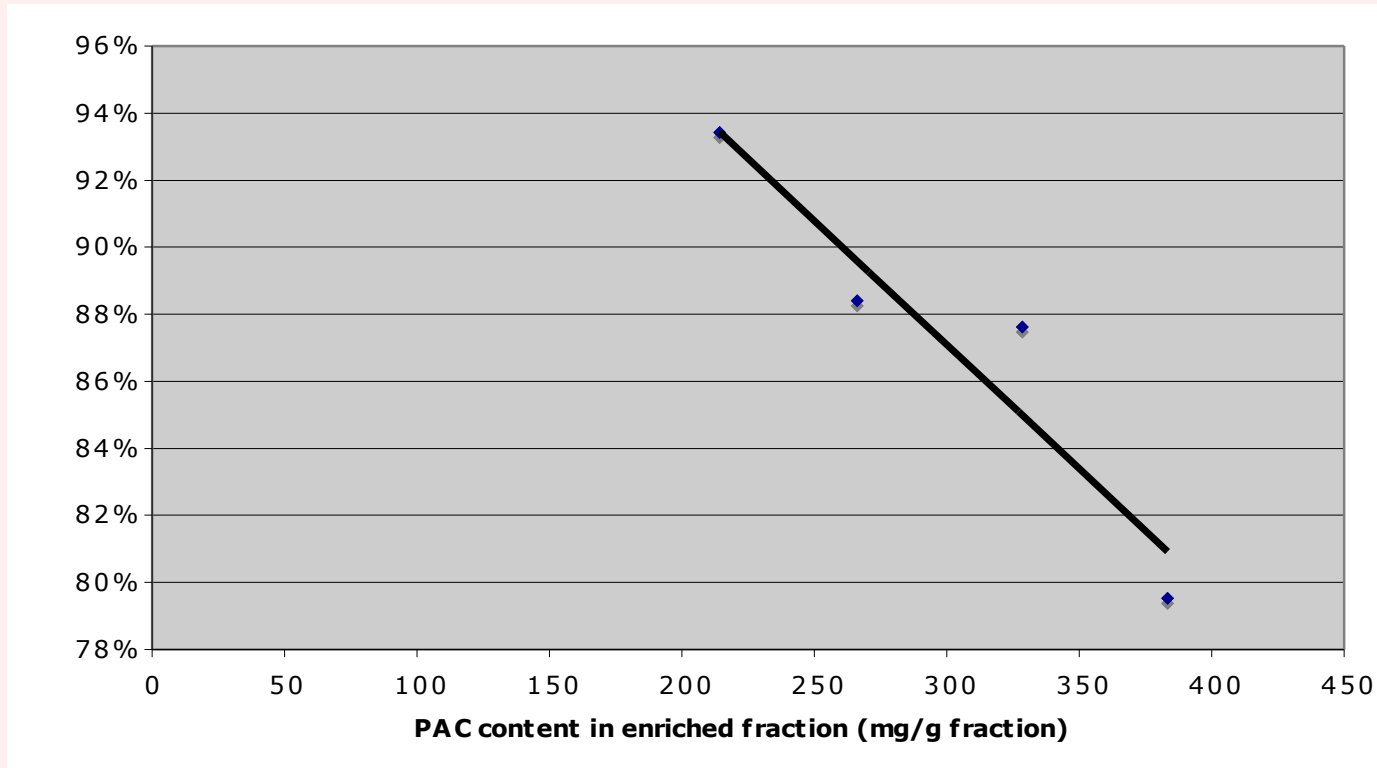


Lipid (fat accumulation) Inhibition



- Most surprisingly, fractions high in PACs were the ones who were more active, as opposed to the ANC fractions.

Trend vs. PAC content

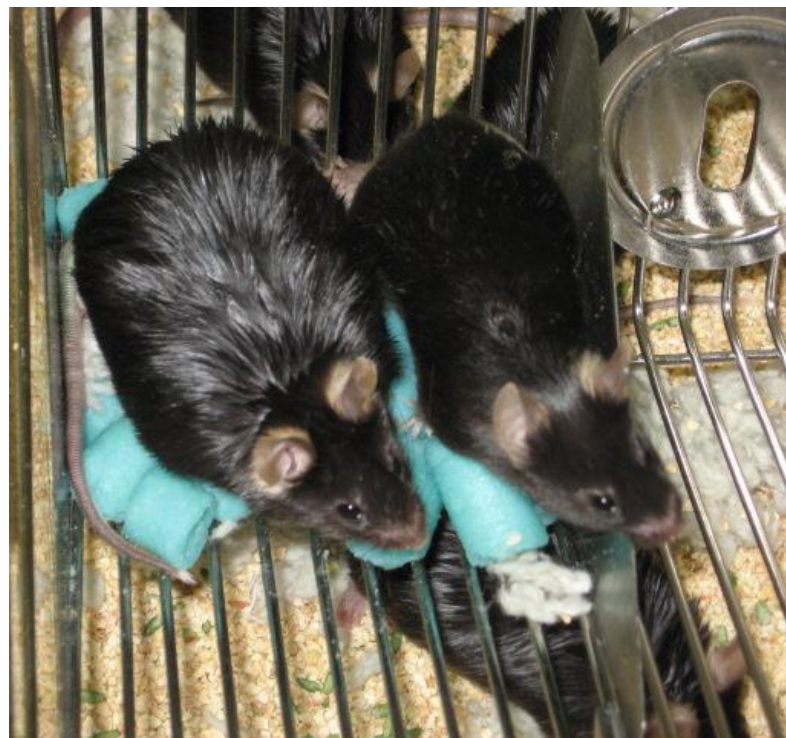


- The PAC content of the fraction correlated very well with the lipid accumulation inhibition, with a linear trend and an R-squared of 0.896.

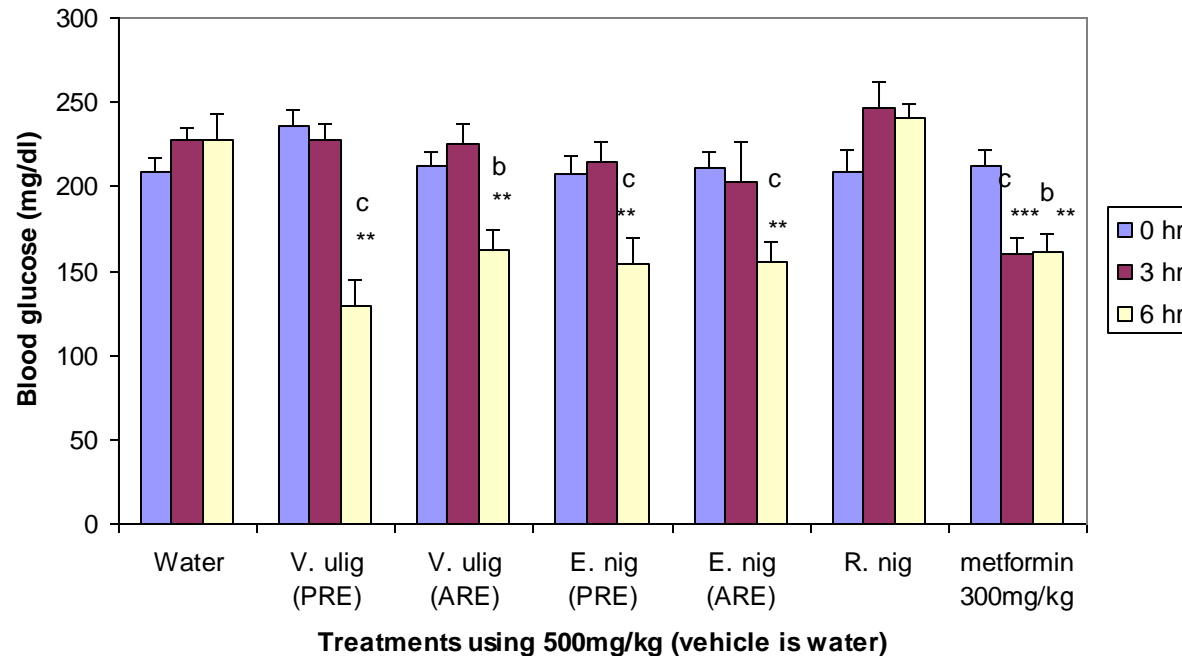
Acute Model for Testing Hypoglycemic Activity

Important Tool for Testing Small Amounts of Material Quickly

- C57 BL/6J obese mice maintained on a high fat diet to induce obesity, insulin resistance and diabetes
- 4 h food restriction
- Treatment by gavage
- Monitor blood glucose up to 8 h
- Economical



Alaskan Berry Extracts Exhibit Hypoglycemic Activity 6 hr after Treatment in Dietary Induced Obese C57bl/6 mice



*: $p < 0.05$ vs initial
 **: $p < 0.01$ vs initial
 ***: $p < 0.001$ vs initial

a: $p < 0.05$ vs water
 b: $p < 0.01$ vs water
 c: $p < 0.001$ vs water

V. ulig: *Vaccinium uliginosum*
 E. nig: *Empetrum nigrum*
 R. nig: *Ribes nigrum*

**Berry bioactives composition
(ANC & PACs) intensified at
northern extremes; A-type
PACs**

**Pref 1 levels enhanced by berries, but
not PACs or ANC**

**PAC content correlated with inhibition
of lipid deposition**

**Significant hypoglycemic activity of
berries (ANC)**

**Phytochemistry & Bioassays both
validate TEK**











Wellness and Prevention

- *“We work with community health workers, community members and volunteers, in a multi-disciplinary, holistic approach - addressing mind, body and spirit. Our programs support hands-on education, increasing skills and providing capacity-building at a community level, with the goal of having sustainable programs that promote wellness and prevent disease. We believe that the community has the ability to heal itself, when provided culturally-based education, nurturing and support.”*
- *DCHS Core Business Statement*



A Changing Picture....

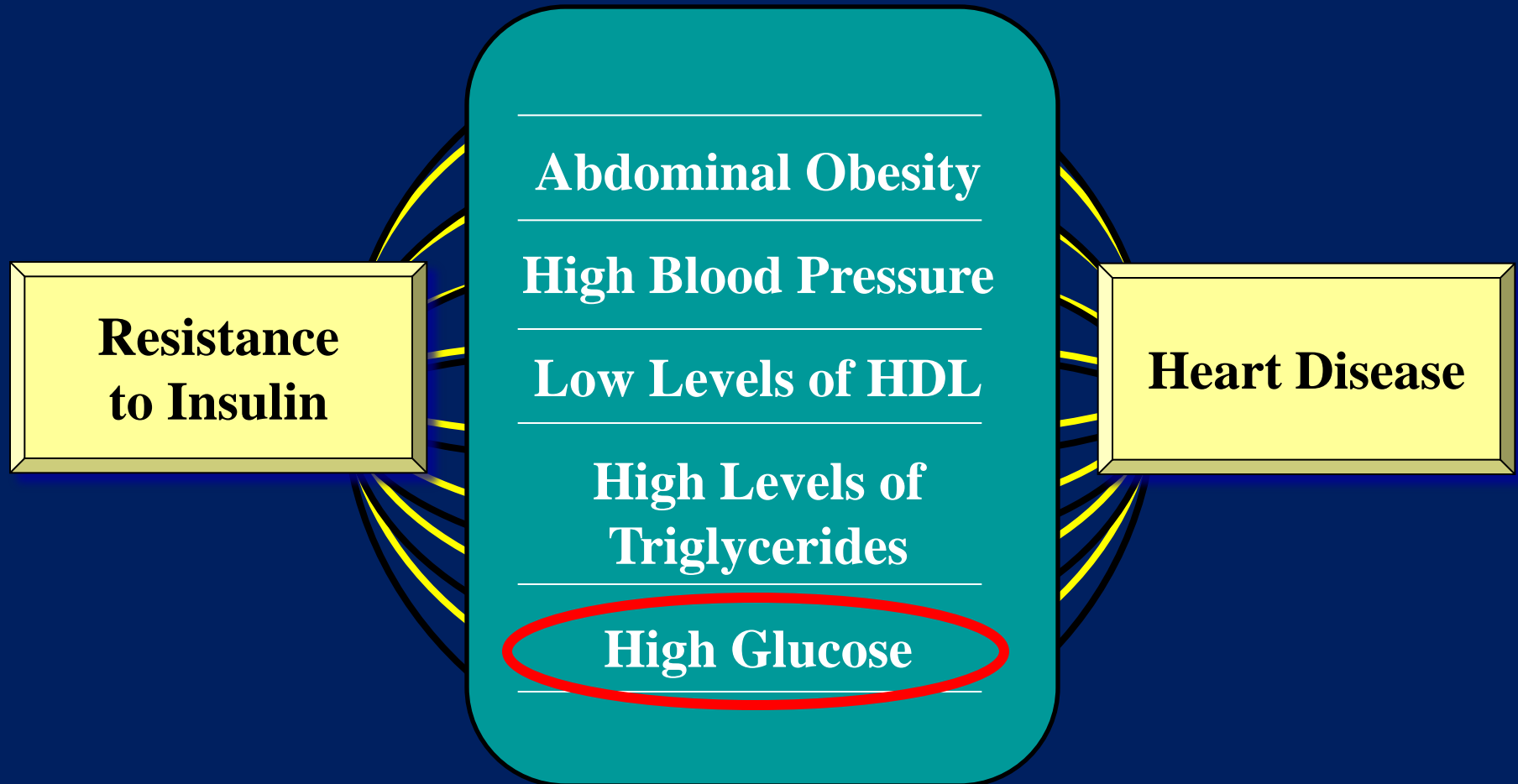


Alaska Tribal Health System Mortality

- Malignant Neoplasms: 194.5/100,000
- Heart Disease: 131.8/100,000
- Unintentional Injury: 100.8/100,000
- Alcohol related: 61.2/100,000
- Suicide: 45.9/100,000
- Firearm Injury: 40.2/100,000
- Cerebrovascular Disease: 35.8/100,000
- Pneumonia & Influenza: 17.0/100,000
- Homicide: 13.4/100,000
- Diabetes: 10.8/100,000

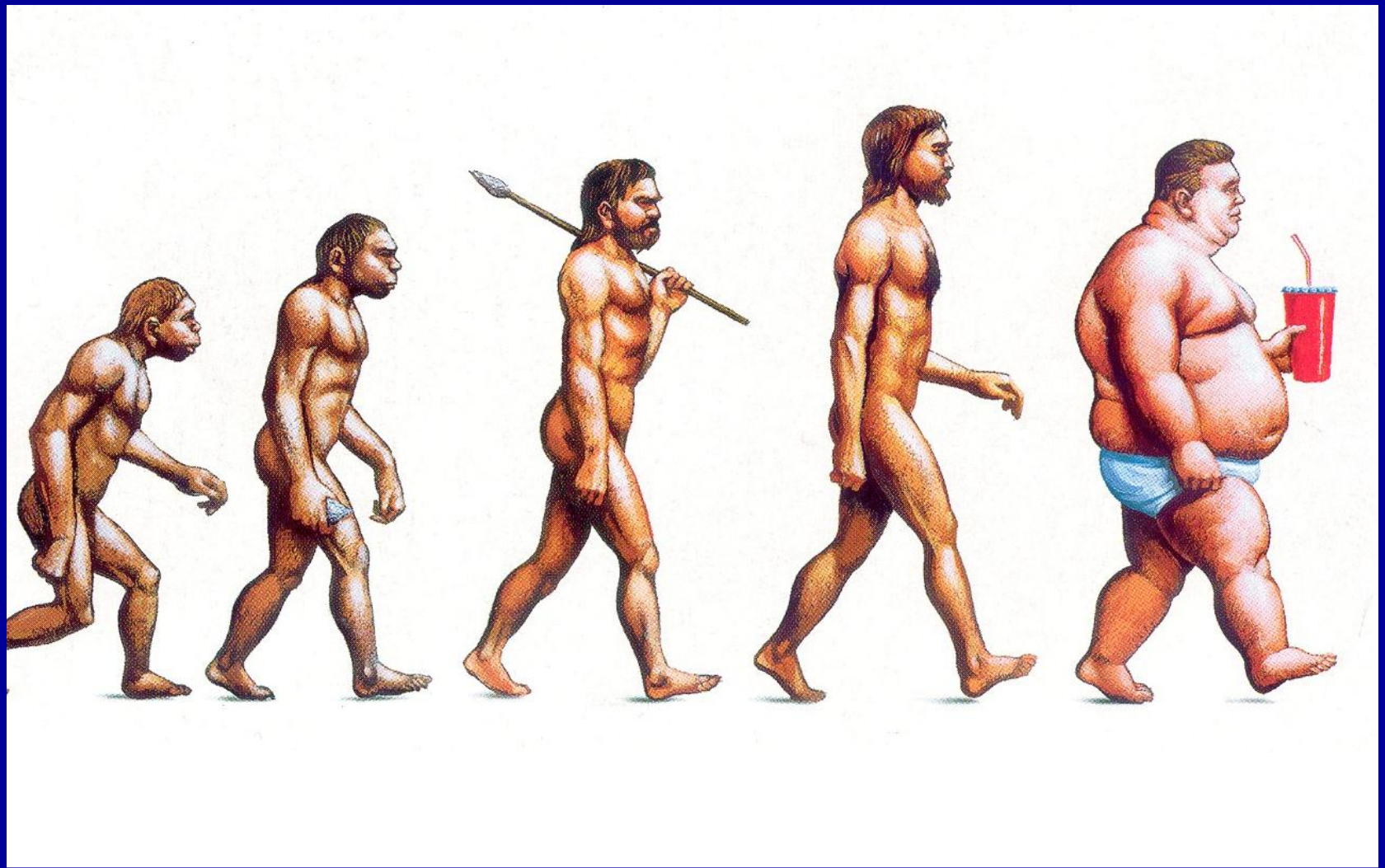


The Metabolic Syndrome









“Let foods be your medicine”
-Hippocrates



ALASKA SPORTSMAN: THE BEST HUNTING SPOTS

Alaska
INSIDE
SPECIAL SECTION
for Alaskans Only

Alaska

The Store Outside Their Door

CAN NATIVES SUSTAIN THE
SUBSISTENCE LIFESTYLE?

RANGER'S





An Integrative Team...





Healthy Communities



- Community Ownership
- Utilizing Community Resources
- 'Environment' of Wellness